Periodic Testing Limits - Avgas

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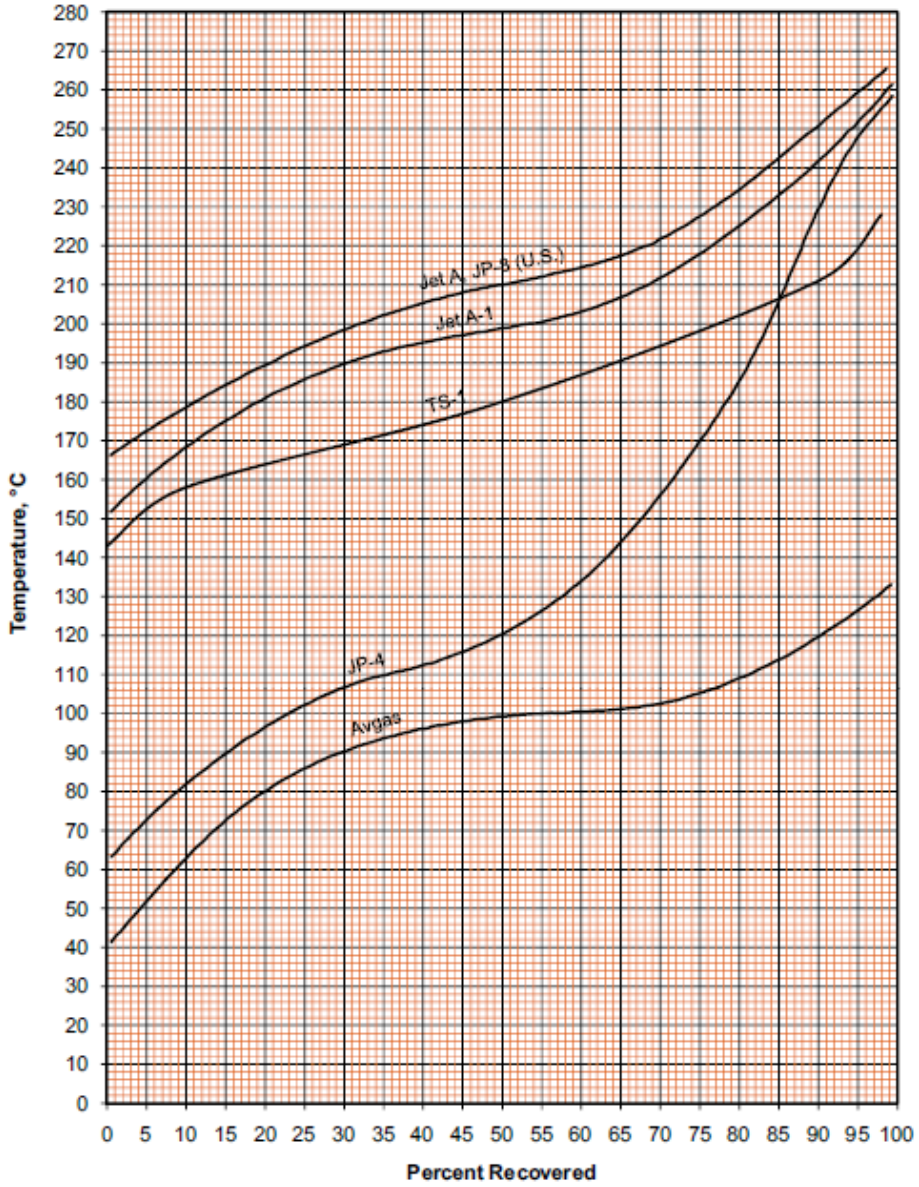
Weathering – An Introduction

After manufacture, fuels can and do change in storage.

- Chemical reactions in the fuel can lead to polymerisation, oxidation and gum formation.
- Components can evaporate
  - More of a problem for Avgas than Jet Fuel as it is more volatile (forms a vapour more easily)

- To deal with this we require periodic testing of the fuel to ensure it is still on specification.
- In the supply chain EI/JIG 1530 requires that fuel has a RCQ/CoA/RT less than 180 days old.
- At airports periodic testing is required every 6 months for stagnant stocks.

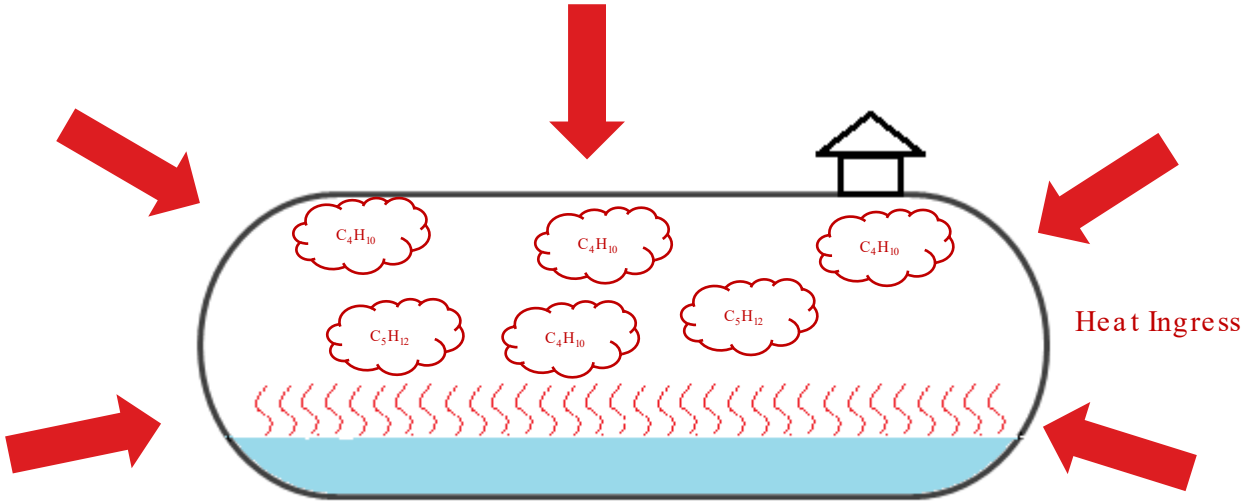


Evaporation

Fuels contains many components, some lighter and easier to evaporate than others.

Avgas is more sensitive than Jet and the loss of volatile components in storage depends on several factors:

- Time in storage
- Above ground tanks are more prone to evaporative losses than underground tanks
- A small amount of fuel relative to the tank size (i.e., a large relative ullage volume)
- High ambient temperatures
- Lack of effective pressure / vacuum vent valves
- Changes in fuel formulations practice that can occur between different manufacturing sources.



Evaporative Loss - Learning from Incidents

- Prior to the first delivery of a new Avgas grade from a new supply source, the receiver's internal protocol required an inspection of the supply point.
- There was not an opportunity to run a pre -inspection of the new supply location but the receiver accepted the latest inspection report from a 3 rd party Oil Major which indicated no significant issues.
- In accordance with JIG2 and EI/JIG1530 all the required documents including the CoA of the supply tank and the Release Certificate (RC) for the delivery road tanker were provided by the fuel supplier prior to arrival of the dedicated Avgas road tanker.

At the Airport Receipt

- When the Avgas road tanker arrived at the airport, the vehicle was sampled and a Control Check was performed. This showed the fuel to be bright and clear with a density 2.6 kg/m ^{3} higher than the density on the supply tank RC (within the maximum permitted limit of 3.0 kg/m ^{3}).
- On that basis the decision was made by the receiving airport to discharge the product in line with industry standards and practices.

At the Airport Receipt

- Due to the lack of inspection oversight, the receiving company had elected to conduct a full CoA test on the Avgas road tanker in addition to the industry minimum controls.
- The results of the full CoA test showed that the road tanker Reid Vapour Pressure was off-spec at 35.7 kPa (versus 38.0 kPa min.) and the T10 distillation property was off -spec at 77 ^{o}C (versus 75^{o}C max.)

- *RVP is the pressure at which a fuel forms a stable vapour.*
- *T10 is a measurement of the temperature at which 10% of the fuel is recovered during distillation.*
- *A reduction of light material (such as through evaporation) results in the lowering of the RVP and an increase in T10*

The Data

Note that in accordance with industry guidelines, the Supplier had a product that had a COA less than 180 days old (as requir ed by EI/JIG 1530).

All other standard industry handling protocols and controls were also met, but it remains that the fuel was supplied off -specification.

	unit	method	spec	tank T22 CoA	Truck-RC (1, 4, 5, 6)	Truck at Airport (composite 1, 4, 5, 6)	truck vs CoA	R (test method)
date				22/01/2020	31/03/2020	06/04/2020		
sample date				13/01/2020		02/04/2020		
batch					19-22-06			
lab-No				130120-000102	130120-00102			
volume	m3				29	29		
Appearance		visual	B&C	B&C	B&C	B&C		
d15	kg/m3	ASTM D4052	report	705.6	707.9	708.2	2.6	
RVP	kPa	ASTM D5191	38,0 - 49,0	40.3		35.7	-4.6	1.58
IBP	°C	ASTM D86	report	34		36		
T10	°C	ASTM D86	max 75	71.1		77	5.9	4

Why Might This Have Happened?

- RVP on the supply point tank's last COA was unusually low at 40.3 kPa (but on -spec versus 38.0 kPa min.)
- The road tanker was loaded 2 ½ months after the supply point tank sampling date on the COA.
- Weathering (evaporation losses) apparently occurred/continued in the Avgas supply point tank to further lower RVP (and increase the T10) before the road tanker was loaded.
- The higher density of the road tanker (2.6 kg/m ^{3} higher) versus the Supply Tank COA density was likely also due to weathering. However as it was within the 3.0 kg/m ^{3} industry acceptance tolerances for both supply point release and airport acceptance of the road tanker, it was not signalled as an issue.

Analysis of Controls

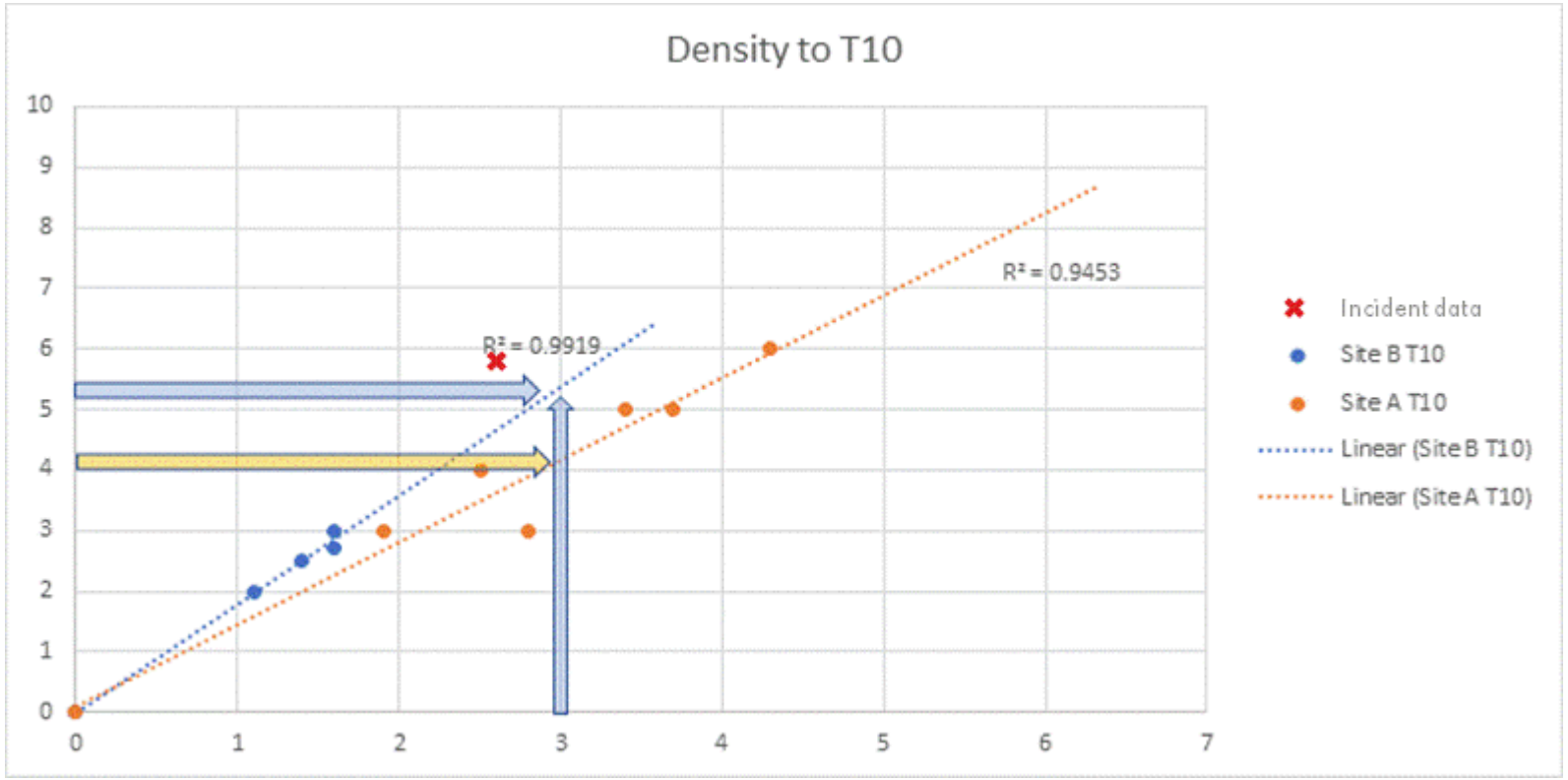
How effective are the controls at the airport?

2

Can we Detect a T10 Variation with Density?

Correlation looks good, but differs slightly with different fuel compositions

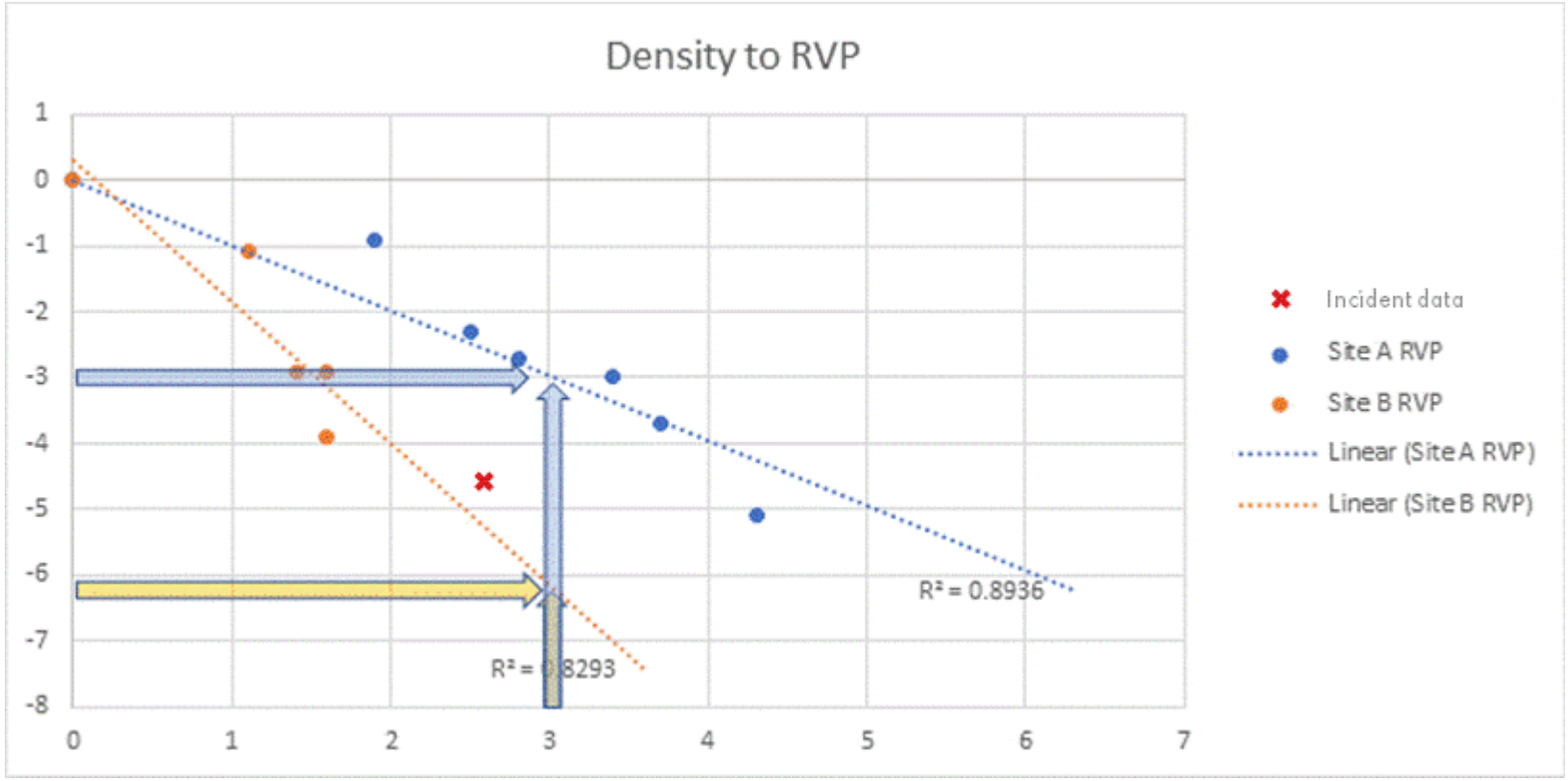
T10 could have increased by up to ~5.5 °C at the density limit for airport receipt.



Can we Detect a RVP Variation with Density

Correlation looks good, but differs significantly with different fuel compositions

RVP could have decreased by up to 6.2 kPa at the density limit for airport receipt.



The Way Forward

3

Change the Limits for the CoA for Low Flash Products

In this incident, within only 2.5 months of the last COA, the fuel

- *lost 4.6 kPa in RVP*
- *T10 increased by 5.9°C*

If we are to keep 180 day testing:

Analysis of Density sensitivity would suggest that to ensure on spec product then revised CoA limits should be:

- RVP limit of 45 kPa min
- T10 of 69 °C max

Issues:

1) *Restrains terminals from supplying otherwise on-spec fuel.*
2) *Increased downgrading / disposal of challenging product.*
3) *Increase in cost to supply*

Rejected

Change the Period of Testing for Low Flash Products

In this incident, within only 2.5 months of the last COA, the fuel

- *lost 4.6 kPa in RVP*
- *T10 increased by 5.9°C*

If we are to keep 180 day testing:

Increase CoA testing for low flash fuels to 90 days or even 30 days.

Issues:

1) Onerous on suppliers if all fuels, (even those with adequate margin), are tested often.
2) Product can still be released on the limit with no margin for further weathering downstream
3) Density limits on receipt are not an adequate control for ensuring on - spec fuel.

Rejected

Conclusion – A Hybrid Approach

A 3 kg/m ^{3} density limit on airport receipt appears to be useful in identifying failing fuels if margins are above 45 kPa min RVP / 69 ^{o}C max T10

1) 180 day testing remains if product at terminals test outside of the above limits.
2) Terminals shall increase testing frequency of T10 and RVP to at least every 30 days once below these limits.
3) Terminals should use these data to determine a rate of change to ensure that the product will remain within specification limits while on supply.

Issues:

1) More complex for terminals to operate, but better assurance that fuel is on spec at the point of custody transfer.
2) Product can still be released on the specification limit with little margin for further degradation at the airport.

Accepted

Airport Operations

What about airports?

3

Fuel Must Meet Spec at Point of Aircraft Fuelling.

- Avgas evaporation can continue to occur at the airport.
- Factors that affect the rate of evaporation include:

- Above ground tanks are more prone to evaporative losses than underground tanks
- A small amount of fuel relative to the tank size (i.e., a large relative ullage volume)
- High ambient temperatures
- Lack of effective pressure / vacuum vent valves
- Changes in fuel formulations practice that can occur between different manufacturing sources.

Airport Actions

Where incoming Avgas release certificates show:

RVP < 45 kPa

And/or

T10 > 69 °C

- Airports should be aware of the potential for fuel properties to change within the normal 6-month periodic testing period (JIG 2
- Trend monitoring of the rates of change of both RVP and distillation (especially T10) at the storage location should be used to predict the maximum period that a given fuel might reasonably be expected to remain on spec specification limits while on supply.

NOTE: Care needs to be taken when sampling and storing Avgas samples to ensure they are representative of the fuel in the bulk tank. Especially true when testing for marginal volatile properties. See Backup Slide

JIG Bulletin

Bulletin to be released

Action for JIG 2 (airport storage) operations

Action for EI/JIG 1530 compliant supply terminal operations

EI/JIG 1530 has no mechanism for changes to content between revisions (such as Bulletins) so JIG is aiming to communicate though a Bulletin to the community upstream of airports and expects JIG members to adopt these practices.

Expected publication: end Q2/21.

Questions and Answers

Background Information – Sample handling for T10 and RVP. See ASTM D4057 for guidance

At the Airport

- Test to be performed on samples from primary sample container, and not a composite.

  The extreme sensitivity of vapor pressure measurements to losses through evaporation and the resulting changes in composition is such as to require the utmost precaution and the most meticulous care in the handling of samples.
- Protect samples from excessive temperatures prior to testing.
- Do not test samples in leaky containers. They should be discarded and new samples obtained.

At the Lab

- At the lab, the Reid vapor pressure determination shall be performed on the first test specimen withdrawn from the sample container.
- The remaining sample in the container cannot be used for a second vapor pressure determination.
- Test labs shall cool the sample container and contents to 0 to 1° C (32 to 34° F) before the container is opened.
- Sufficient time to reach this temperature shall be ensured by direct measurement of the temperature of a similar liquid in a like container placed in the cooling bath at the same time as the sample. Refer to Practice ASTM D5854 (API *MPMS* Chapter 8.3).